SPROUTING OF BLACKJACK OAK IN THE MISSOURI OZARKS

BY
F. BRYAN CLARK
FRANKLIN G. LIMING

CENTRAL STATES
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PHILIP A. BRIEGLEB, DIRECTOR

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Franklin G. Liming, Forester-in-Charge

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Frontispiece.--Low-grade stand, typical of those used in the study, containing many blackjack oak and other low-value trees. Under proper management such trees would be replaced with more desirable trees.

SPROUTING OF BLACKJACK OAK IN THE MISSOURI OZARKS

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F. Bryan Clark and Franklin G. Liming[1/]

Almost all hardwood trees in the forests of the Missouri Ozarks are prolific sprouters. This ability plays an important role in the development of both managed and unmanaged forests.

The ability to sprout is a big help in maintaining a forest cover. It is primarily responsible for the very existence of most of the hardwood forests in the Ozarks today Persistent attempts for more than half a century to clear land have been unsuccessful on about half the original forested area in the State. These attempts, although unsuccessful in eliminating the forest cover, have drastically reduced the quality and productivity of the remaining forest stands.

As a result, much of Missouri's 15 million acres of forest land has too few sound trees of commercial species, particularly in the larger size classes. Most stands contain many trees of non-commercial species such as blackjack oak (Quercus marilandica Muenchh.) and trees that are not merchantable because of defect. About 1 out of every 3 trees is not now and never will be merchantable by present standards.

The forests cannot be fully productive as long as these non-merchantable trees remain and occupy space that could be used by better trees. Moreover, these undesirable trees compete with the better trees. The percent of undesirable trees would decrease in time if misuses were discontinued, but the process would be discouragingly slow. Artificially eliminating these undesirable trees would greatly reduce the time required to restore full productivity.

It is in the artificial elimination of undesirable trees that sprouting ability becomes a liability instead of an asset. Removing or killing the tops of these trees is no problem. The greatest obstacle in removing blackjack oak and other undesirable trees is that they readily sprout after the tops have been killed. The sprouts that develop after such treatment keep the base of the stem and the roots alive Because of their rapid early growth, sprouts soon occupy much growing space and again compete with other trees. The problem is how to kill the tops of the trees and at the same time prevent or greatly reduce sprouting.

1/ Forester and Forester-in-Charge, respectively, Northern Ozark Forest Research Center.

Success stories about how to eliminate the forest cover are common among farmers of the Missouri Ozarks. Many of these methods involve a special way of girdling or a special time for girdling or cutting. Although some attempts succeed, particularly on the larger trees, most of them fail because of repeated sprouting. Generally it is necessary to supplement cutting and girdling with repeated, time-consuming "sprout chopping" or with the site-destructive practices of repeated burning or heavy goating. So failures are fairly common and many areas are allowed to revert to forest--generally an inferior forest. None of the local practices are considered completely dependable and acceptable, but they do provide leads for study.

STUDY MADE IN THE MISSOURI OZARKS

In 1939 the Central States Forest Experiment Station, in cooperation with the Mark Twain and Clark National Forests, began a series of studies on the sprouting of hardwood trees, particularly blackjack oak. These studies were intended primarily to find out how different methods and times of girdling and cutting affect subsequent sprouting, and to find out if sprouting is correlated with certain tree characteristics.

The results of these studies have been helpful in designing recent studies to test several newly developed chemicals for the control of woody plants. The information presented should help those who are trying to eliminate undesirable hardwood trees from forest stands as well as those who are planning research in the chemical control of woody plants.

LOW-GRADE OAK STANDS USED

Blackjack oak sprouting was studied in low-grade, second-growth oak-hickory stands (frontispiece) in Howell and Dent Counties. These stands have developed since the original stands were harvested near the close of the last century. They were repeatedly burned, high-graded, and overcut until the early 1930's when they were made a part of the Mark Twain and Clark National Forests. When the study was begun the trees averaged about 50 years old, 6 inches d.b.h., and numbered about 340 1-inch d.b.h. and larger per acre. Very few sawtimber trees remained in the stands. The canopy was about 80 percent closed. About 53 percent of the trees were blackjack oak. Trees of faster growing species--black oak (*Quercus velutina* Lam.), scarlet oak (*Q. coccinea* Muenchh.), white oak (*Q. alba* L.), hickory (*Carya* spp.), and shortleaf pine (*Pinus echinata* Mill.)--were a little larger and took up slightly more than half the occupied growing space. Most of these stands are located on Clarksville

stony loam soil on ridgetops and upper and south slopes, which are poor to fair sites for hardwoods and fair to good sites for pine. They are typical of stands on extensive areas where blackjack oak and other low-value hardwoods should be eliminated or greatly reduced and shortleaf pine or some other species of greater value should be increased.

The diameter at breast height of blackjack oak trees considered in this study averaged 5.4 inches but ranged from 1 to 14 inches. Total height averaged 29 feet, live crown length 14 feet, and crown area 84 square feet. Ten percent of the trees were in the dominant crown class, 39 percent codominant, 39 percent intermediate, and 12 percent overtopped. Study trees were scattered irregularly among trees of other species.

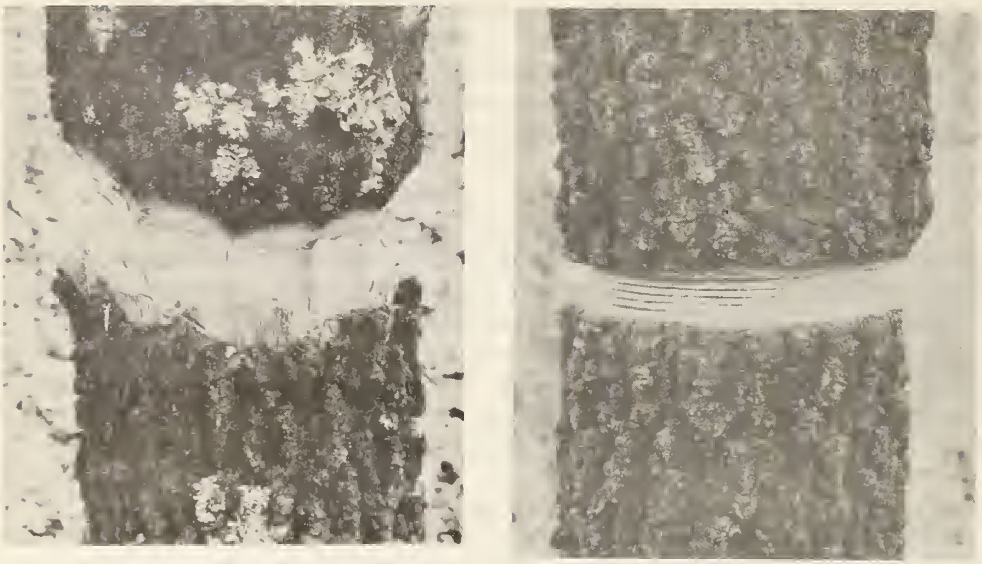
2,400 BLACKJACK OAK TREES GIRDLED

Most of the information presented in this paper came from a study of 2,400 blackjack oak trees distributed evenly among five plots in each of the two counties. Each plot was made large enough (average of 1.4 acres) to include just 240 run-of-the-woods blackjack oak trees 1-inch d.b h. and larger. The five plots in each county were selected at random from more than 25 stands of typical low-grade forests.

Ten trees selected at random on each plot were notch girdled and ten were peel girdled on about the 15th of each month. The trees were girdled about 3 feet above the ground. The notch girdle is used locally and extends about one-fourth to three-fourths of an inch into the sapwood (fig. 1A). The peel girdle as the name implies, was meant to extend through the bark only. However, in making certain that a complete ring of bark was removed without greatly increasing girdling time, small amounts of sapwood were accidentally removed on some trees. The depth of the peel girdles into the sapwood ranged up to 0.2 inch. This type of girdle (fig. 1B) was made with a special girdling saw,[2/] but a similar girdle with an axe probably would have been equally effective.

Information on sprouting of black, scarlet, white, and post oak (Quercus stellata Wangenh.) was obtained from studies designed primarily for other purposes. Although the data are not as extensive as those for blackjack oak it was evident that the general relationships that exist between treatments and tree characteristics and the development of sprouts on blackjack oak are about the same for these other species.

2/ Franklin G. Liming. Two new girdling saws. Jour. Forestry 39:12. 1941.



A B

Figure 1.--Types of girdles tested: A, notch girdle extending one-fourth to three-fourths inch into the sapwood; B, peel girdle extending 0.0 to 0.2 inch into the sapwood.

In addition to the information on the depth and time of girdling, a record for each treated tree was made of the diameter at breast height, crown size, crown class, and the extent of competition by trees of other species. The effects of these factors on sprouting were evaluated in terms of the amount of sprouting and the size of sprout clumps

BASIC INFORMATION OBTAINED

In Missouri most, if not all, oak sprouts originate from dormant buds, i.e., buds that are present but usually do not develop into sprouts or branches unless the "natural balance" of the tree is upset. If the crown of a blackjack oak tree is killed either by cutting or girdling, some of the buds on the stem below the cut or girdle may develop into sprouts.

Most of the trees that were girdled during the growing season sprouted during the same growing season. Sprouting on some of the trees girdled late in the growing season and on those girdled during the dormant season occurred early in the following growing season. Generally, a tree that had not sprouted by the end of the second year did not sprout at all.

The average height growth of sprouts on peel-girdled trees the first year was five times greater than the average annual height growth for the following 5 years. Sprouts on notch-girdled trees grew four times faster during the first year than the average for the following 5 years.

Most of the sprouts originated near the base of the treated trees. Two years after treatment sprouts were distributed on the stems below the girdle as follows: 53 percent on the lower 3 inches, 9 percent on the upper 3 inches, and 38 percent between. Six years after treatment, 80 percent of the dominant sprouts (those dominating all other sprouts within individual sprout clumps) were located on the lower 6 inches of the stump, 12 percent on the upper 6 inches of the stump, and 8 percent on the middle of the stump. The location of sprouts on the stumps varied only slightly among the various months and between types of girdle.

PEEL GIRDLING BETTER THAN NOTCH GIRDLING

Depth of girdling determines which functional elements of the tree are severed. Both notch and peel girdling remove a complete ring of bark from the tree. Since the inner bark contains the food-conducting elements, both types of girdling stop or greatly reduce the movement of food from the crown to the roots of the tree. Notch girdling also removes the outer layers of sapwood, which contain most of the active water-conducting system. This greatly reduces the water supply to the crown. Peel girdling removes only a small portion, if any, of the water-conducting system and has little direct effect on the water supply to the crown.

When the water supply to the crown is reduced by a notch girdle during the growing season, the crown usually dies of desiccation within a few weeks. If girdling is done during the dormant season, the crown will usually die within a few weeks after the beginning of the next growing season. The roots still have a water supply and some stored food and so remain alive for some time after the crown dies. Buds on the stem below the girdle generally remain dormant while the crown is alive When the crown dies, some of these buds develop into sprouts. These sprouts soon provide a new source of food to the roots.

The peel girdle usually does not reduce the water supply to the crown enough to cause its death. Although a few of the buds below the girdle may develop into sprouts while the crown of the peel-girdled tree is still alive, most of them do not. The stem below the girdle and the roots stay alive until the stored food is exhausted or greatly reduced. When this happens, many or all of the roots die and no longer provide an adequate water supply to the

crown and it then dies. By the time the top dies, the buds on the stem below the girdle have died or are so weakened that they either do not develop into sprouts or produce only weak sprouts. Since many of the roots are dead and the food supply in the live roots is at a low level, the sprouts that do develop have a low growth rate and a high mortality.

Amount of Sprouting

During the first six growing seasons, 79 percent of the trees notch girdled had sprouted, but one-fourth of these sprout clumps had died by the end of the 6-year period. On the other hand, only 69 percent of the trees peel girdled had sprouted and one-third of these died. Not only do fewer trees sprout when peel girdled but sprout mortality is higher.

The net effect was that six growing seasons after treatment, 61 percent of all trees notch girdled had living sprouts and only 46 percent of all trees peel girdled had sprouts. One-fourth fewer peel-girdled trees had sprouts than trees notch girdled and the difference is significant at the 1 percent level.[3/]

After six growing seasons there was little difference in amount of sprouting among trees girdled one-fourth to three-fourths of an inch into the sapwood (fig. 2). Apparently no great increase in sprouting can be expected by increasing the depth of girdle beyond three-fourths of an inch. However, some evidence from another study indicates that small increases in percent of trees sprouting may be expected when the stem is completely severed.

A decrease in the depth of girdle below one-fourth inch resulted in a definite decrease in the percent of trees sprouting (fig. 2). Further reductions probably could be obtained if sufficient care were taken to remove a ring of bark without injuring any sapwood. From the practical standpoint, if a girdle cannot be made less than one-fourth inch deep into the sapwood, it makes little difference how deep the girdle is made. But it must be remembered that in making a girdle, an ax-cut into the sapwood, even though the chip of wood is not removed, is essentially the same as making a notch since it severs the water-conducting elements.

After two growing seasons, peel girdled trees had an average of 6.7 sprouts per tree; and trees notch girdled had an average of 7.4 sprouts per tree. The trees that were peel girdled had 9 percent fewer sprouts per sprouting tree than trees notch girdled and this difference was significant at the 5 percent level.

3/ Significant at the 1 percent level means that on the average differences as great as those found will not occur more than 1 time out of 100 as a result of chance (5 times out of 100 at the 5 percent level) as determined by analysis of variance.

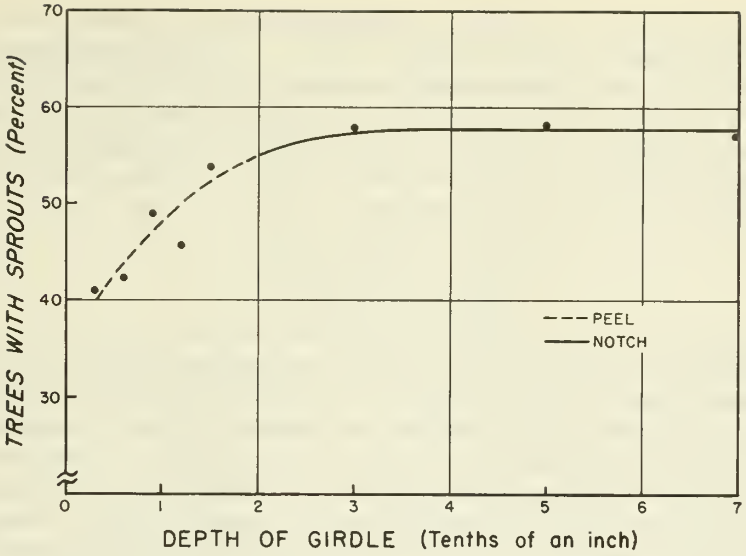


Figure 2.--Percent of trees with sprouts 6 years after girdling by depth of girdle.

Sprout Growth

Sprouts originating from trees peel girdled grew slower than sprouts originating from trees notch girdled during the 6-year period that observations were made. Differences in height growth did not occur until after the first growing season. Sprout clumps from both notch- and peel-girdled trees grew about 26 inches in height during the first growing season. However, at the end of six growing seasons, sprout clumps from peel-girdled trees were 51 inches high while sprout clumps from notch-girdled trees were 61 inches high. This 16 percent difference in height is significant at the 1 percent level.

The differences in crown areas of sprout clumps on trees treated by peel girdling and notch girdling was also significant at the 1 percent level at the end of six growing seasons. Sprout clumps on trees notch girdled occupied an average area of 16 square feet and clumps from trees peel girdled occupied 12 square feet.

JUNE BEST MONTH FOR GIRDLING

Many local farmers who have had experience in clearing land claim that there is a "right time of the year" to girdle in order to reduce sprouting. But there is no general agreement as to the "right" time. Nevertheless, since the food supply in the stem below the girdle and in the roots may affect sprouting, time of girdling may also affect sprouting.

In the Missouri Ozarks, diameter growth of oaks usually starts early in May and ends late in July. Trees grow fastest in June. Since much of this growth is made on stored food, the stored food is at a low level during the period of active growth and just before food surpluses from the crown begin to accumulate. Therefore, sprouts have less food reserve to grow on when the trees are girdled in the active growing season.

Amount of Sprouting

Fewer of the June-girdled trees sprouted than did trees girdled in any other month (fig. 3). The percent of trees with sprouts ranged from 18 percent for trees peel girdled in June to 75 percent for trees notch girdled in January. The differences in trees with sprouts between June and all other months for notch girdling and between June and all months except May and July for peel girdling were significant at the 1 percent level. For each month the relationship between notch and peel girdling was the same as previously discussed, i.e., notch girdling resulted in more trees with sprouts than peel girdling.

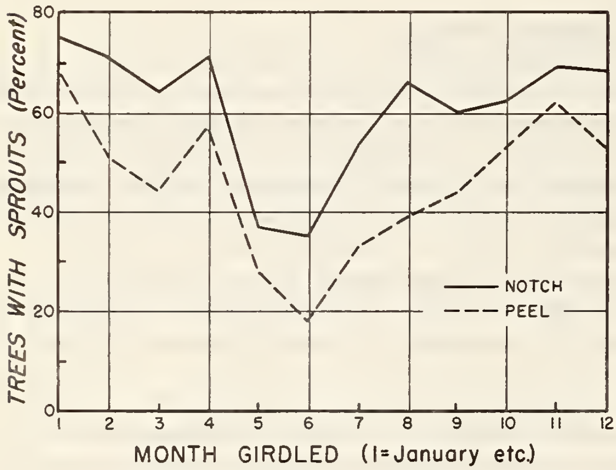


Figure 3.--Percent of blackjack oak trees with living sprouts 6 growing seasons after girdling by month and type of girdling.

The differences among months in percent of trees with sprouts at the end of 6 years are due to differences in the actual number of trees sprouting during the 6 years and in the mortality of sprout clumps. Months having the lowest percent of trees sprouting had the highest mortality of sprouts, whereas months having the highest percent of trees sprouting had the lowest mortality (fig. 8 - Appendix). For example, by the end of the 6 years, 38 percent of the sprout clumps from trees notch girdled in June and 55 percent of the sprout clumps from trees peel girdled in the same month had died. On the other hand, trees treated in January had a mortality of only 13 percent for notch and 22 percent for peel girdling. For each month sprout mortality was higher on trees peel girdled than on trees notch girdled.

If the months are grouped according to diameter growth activity, it becomes apparent that treatments made in months when trees are growing rapidly resulted in fewer trees sprouting (table 1 - Appendix). Treatment during the month of the highest diameter growth rate--June--resulted in the fewest trees sprouting; the diameter growth period--May, June, and July--had the next fewest, the entire growing season--May to September--was next; and the dormant season --October to April--had the highest percent of trees sprouting.

Sprout Growth

Girdling trees during the different months resulted in wide variations in the growth rate of sprout clumps (fig. 4). The overall differences among months for height and width after 6 years was significant at the 1 percent level. Sprout growth, like amount of sprouting, was correlated with the diameter growth rate of trees at the time of girdling (table 1 - Appendix). Trees peel girdled in June resulted in smaller sprout clumps than trees treated during the other months. After 6 years sprout clumps from trees peel girdled in June and in the dormant season averaged 24 inches and 59 inches high, respectively. Corresponding figures for trees notch girdled were 42 inches and 65 inches high, respectively. The height of sprout clumps on trees peel girdled in June was 59 percent less than clumps on trees notch girdled in the dormant season.

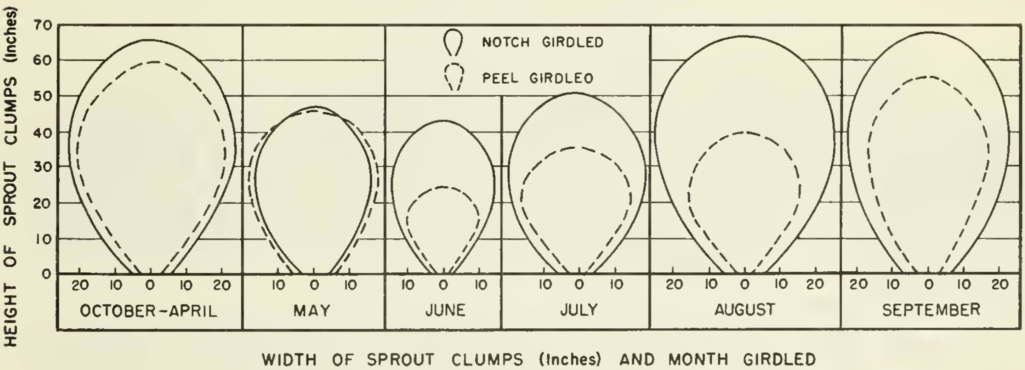


Figure 4.--Average height and width of sprout clump 6 years after treatment by time and type of girdling.

The area occupied by the sprout clumps on girdled trees might better be used for growing higher value trees. In this study an average of 180 blackjack oak trees per acre (53 percent of all trees) were girdled. The crowns of these 180 trees occupied about 15,000 square feet. At the end of six growing seasons the sprout clumps occupied 0.5 to 10 percent of the area occupied by the original crowns, depending upon the method and season of girdling.

(table 1 - Appendix). Peel girdling keeps the sprout clumps smaller than notch girdling for all seasons. Both notch and peel girdling are more effective in June than at any other time. If trees are peel girdled in June instead of notch girdled in the dormant season the area occupied by the sprout clumps after 6 years could be reduced 95 percent.

A further incentive for girdling during June or during any part of the diameter growth period is that it is easier to make a peel girdle when the bark "slips." However, this period comes at a time of the year when farmers may be busy with other crops. If girdling cannot be done during the active growing season, it makes little difference what other time of the year it is done.

TREE DIAMETER CORRELATED WITH SPROUTING

It is generally agreed that large trees sprout less readily than small trees. This may be due to the mechanical barrier of heavy bark, the death of many dormant buds with increased age, or some physiological change in trees as they grow larger. The objective of this study was not to determine the underlying cause for the reduction in sprouting capacity, but rather to determine the actual relationship between tree diameter and sprouting after girdling.

Amount of Sprouting

The relationship between diameter and percent of trees sprouting is inverse; as tree diameter increases, the percent of trees sprouting decreases. This relationship is shown graphically in figure 5. The percent of trees with sprouts at the end of 6 years decreased from 90 percent (notch) and 79 percent (peel) for 1-inch trees to 23 percent (notch) and 5 percent (peel) for 10-inch trees.

The relationship between the number of trees with living sprouts and tree diameter was affected by the mortality of sprouts during the six growing seasons (fig. 9 - Appendix). Sprout mortality was greatest on the larger trees. During the 6-year period, 10-inch trees peel girdled had a sprout clump mortality rate 15 times greater than 1-inch trees peel girdled. The mortality rate for trees notch girdled was lower than for trees peel girdled for all diameter classes.

The relationship between tree diameter and amount of sprouting was found to be the same throughout the year. The smaller trees had the greatest percentage of trees with sprouts for each month.

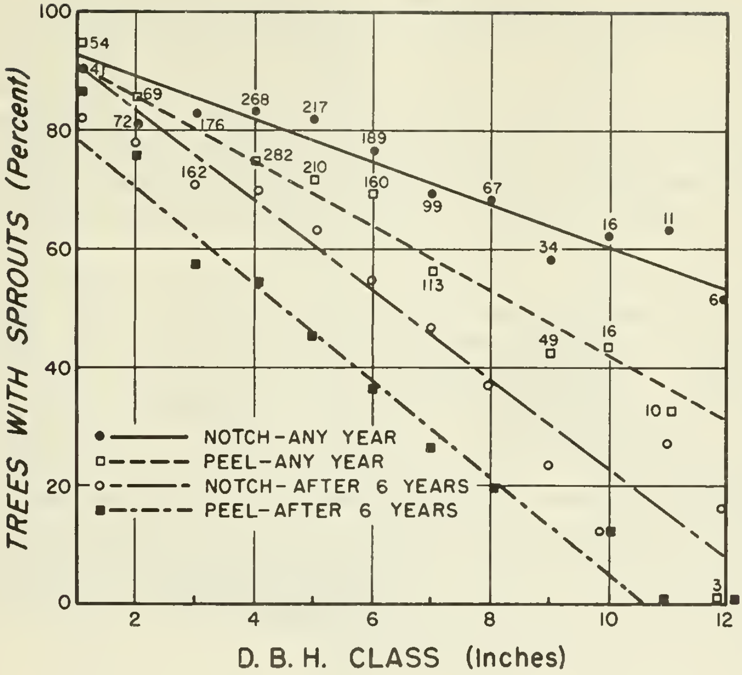


Figure 5.--Relationships between tree diameter and sprouting by type of girdling.

The method and time of treatment is not very important for the larger trees. Any method of killing the tops of the larger trees should result in only a small amount of sprouting; therefore, the choice can be made on the basis of convenience and cost. The relationship between tree diameter and percent of trees sprouting after girdling may explain in part the success that the farmers in the Ozarks have in girdling trees. The general practice in land clearing is to girdle the large trees and cut the small ones. This method is easiest to follow and kills the tops of large trees without stimulating much sprouting.

Sprout Growth

In general trees peel girdled had shorter sprouts at the end of six growing seasons than trees notch girdled. This held true for nearly all diameter classes. The relationships between sprout height on notch- and peel-girdled trees of different diameters do not follow the same pattern as those previously illustrated. After six growing seasons, sprouts on trees that were peel girdled were generally shorter on larger trees than on smaller ones (fig. 10 - Appendix). On the other hand when trees were notch girdled, the

height of the sprout clump after six growing seasons increased as the diameter of the treated tree increased above 3 inches. The differences in heights of sprout clumps on notch- and peel-girdled trees were small for the 1-, 2-, and 3-inch diameter classes but increased greatly as tree diameter increased above 3 inches. Nine-inch trees peel girdled had sprouts 42 inches high after six growing seasons; whereas, 9-inch trees notch girdled had sprouts that averaged 79 inches, nearly twice as high as sprouts from peel-girdled trees.

The relationship between tree diameter and the crown area of sprout clumps six growing seasons after girdling is shown in figure 11 (Appendix). The area occupied by sprout clumps increased as the tree diameter increased up to 6 inches for peel girdling and up to 8 inches for notch girdling. For trees above these sizes the sprout clump areas decreased with further increases in tree diameter. Notch girdling resulted in larger sprout clumps than peel girdling. Differences in sprout area between notch- and peel-girdled trees were small for trees up to 6 inches in diameter, but this difference increased rapidly for trees larger than 6 inches. Sprout clumps on 9-inch notch-girdled trees occupied nearly three times as much area as clumps on 9-inch peel-girdled trees.

WAIST-HIGH TREATMENT BEST

Data on the height of treatment were obtained from a study of the release of pine seedlings from overtopping oak. Notch girdling, peel girdling, and cutting were tried at two heights on the stem: (1) low, 6 inches or less from the ground line, and (2) high, about 36 inches above the ground. All treatments were made during the dormant season.

The amount of sprouting resulting from high and low treatment is shown in figure 6. High treatment resulted in fewer trees with sprouts 11 years after treatment. Although more trees with the high treatment actually sprouted during the 11 growing seasons sprout mortality was much greater on these trees.

The reduction in the number of trees with sprouts obtained by high treatment compared to low treatment is not large, but it is important to remember that it is much easier to work at about waist height. This fact, coupled with the reduction in sprouting that might be expected, makes it desirable to treat at the "high" stump height.

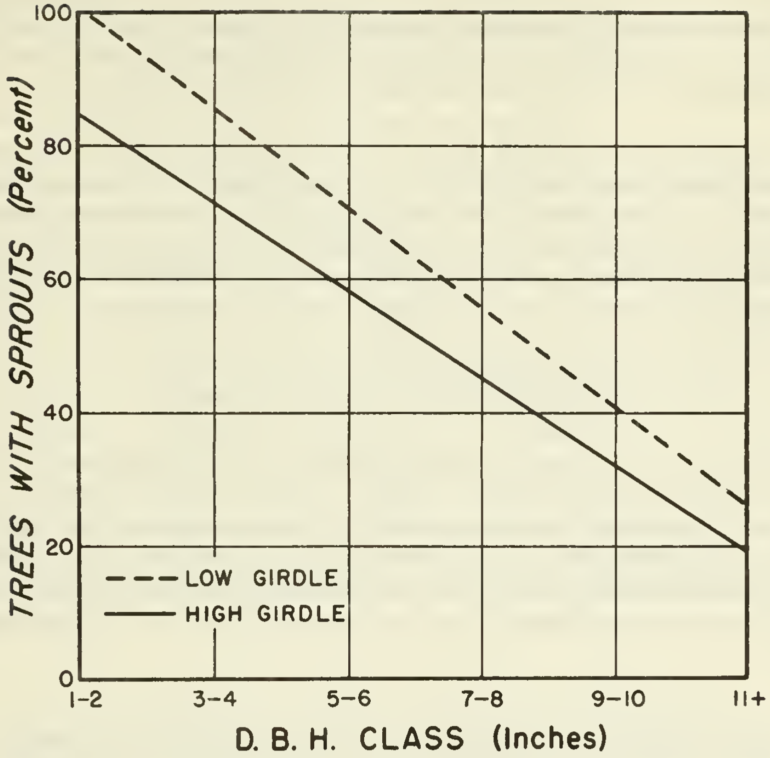


Figure 6.--Percent of trees with sprouts after 11 growing seasons by height of girdle and diameter class.

CROWN CLASS HAD LITTLE EFFECT

Trees used in the blackjack oak study were divided into three classes, dominant-codominant, intermediate, and overtopped, to find out if crown class of the treated trees influenced sprouting or sprout growth. After six growing seasons there were no consistent differences in the number of trees with sprouts by the various crown classes for trees 5 inches and larger. For trees less than 5 inches d.b.h., the proportion of trees sprouting decreased as tree dominance decreased; however, the differences were small. There were no consistent differences in sprout mortality among trees of the various crown classes.

Although crown class has little effect on the occurrence of sprouts, it does affect sprout growth. At the end of six growing seasons, the height (fig. 12 - Appendix) and width of sprout clumps increased with an increase in tree dominance. Sprouts from dominant-codominant parent trees were wider than those from intermediate

trees, which, in turn, were wider than those from overtopped trees. The different growth rates of sprouts by crown class of parent trees may be due to differences in the size and vigor of the root systems or the amount of stored food at the time of girdling.

In addition to crown class, the average widths of the girdled tree crowns were recorded and the 4-inch trees were selected for a comparison of crown width and the percent of trees with sprouts after 6 years. Based on this comparison, it is concluded that the width of tree crowns within a given diameter class does not affect the percent of trees that will sprout after treatment.

COMPETITION NOT VERY IMPORTANT

Treated trees were growing under various degrees of competition from untreated overstory trees. After 6 years there were no apparent differences in the amount of sprouting due to the intensity of competition from untreated trees. For trees up to 7 inches in d.b.h., height growth decreased as competition increased, but there was no difference in height due to competition for trees larger than 7 inches.

EFFECTIVENESS OF TIME SPENT GIRDLING TREES ESTIMATED

The purpose of girdling is to eliminate undesirable trees and provide space for growing more valuable trees or for other uses. The success of girdling depends not only on killing the tops of the trees, but also on preventing or greatly reducing subsequent sprouting. If sprouts develop on the girdled trees, it is usually only a matter of time until these sprouts reoccupy the space occupied by the original trees.

The relative effectiveness of different types and seasons of girdling various-sized undesirable trees has been computed on the basis of the number of trees that could be killed and the amount of crown area reduction that could be made by one man in an 8-hour working day.

TREES KILLED PER DAY VARIES

The number of trees that can be killed by girdling in an 8-hour day depends upon the time required to girdle individual trees and the number of girdled trees that die. The time required to girdle trees increases as diameter increases (fig. 13 - Appendix). Peel girdling with a girdling saw is faster than notch girdling with

an ax for trees less than 8 inches d.b.h. but slower than notch girdling for trees larger than 8 inches d.b.h. The values in figure 13 represent actual girdling time. These values were increased by one minute for between-tree travel time in computing the number of trees that can be girdled in one day.

The number of trees that can be killed in one man-day of girdling is shown in figure 14 (Appendix) by type and season of girdling and tree diameter. Girdling in the active growing season was more effective than in the dormant season and peel girdling was more effective than notch girdling. Of the four treatments, peel girdling in the active growing season resulted in the greatest number of trees killed per man-day and notch girdling in the dormant season resulted in the fewest trees killed. The largest differences among treatments occurred in the 2- to 7-inch classes. Differences were small for diameters larger than 10 inches.

Type and time of girdling are not very important for trees larger than 10 inches d.b.h. However, for trees 2 to 9 inches d.b.h., peel girdling in the active growing season is most effective and notch girdling in the dormant season is least effective.

CROWN-AREA REDUCTION MEASURES SUCCESS

Although the number of trees killed is important from the standpoint of eliminating undesirable trees, the relative sizes of the crowns of the girdled trees and the sizes of the resultant sprout clumps must be considered in evaluating the effectiveness of girdling to create space for more valuable trees. The difference between the total crown area of trees that could be girdled in an 8-hour day and the total area of the sprout clumps on these trees at the end of six growing seasons is referred to here as crown-area reduction and is used as another measure of the effectiveness of time spent in girdling trees.

The relative effectiveness of different types and seasons of girdling different-sized trees is shown in figure 7. Differences in crown-area reduction among the various treatments are not great. This is because the crown area of girdled trees is the same for all treatments and this crown area is the major factor in determining the value of crown-area reduction during the first few years after girdling. Because of the differences in the percent of trees that sprout and the growth rate of sprouts, differences among treatments will increase with time. Furthermore, the crown-area reduction for all treatments will decrease with time. This is not too serious because the greatest benefit to other trees is most likely to occur during the first few years after girdling.

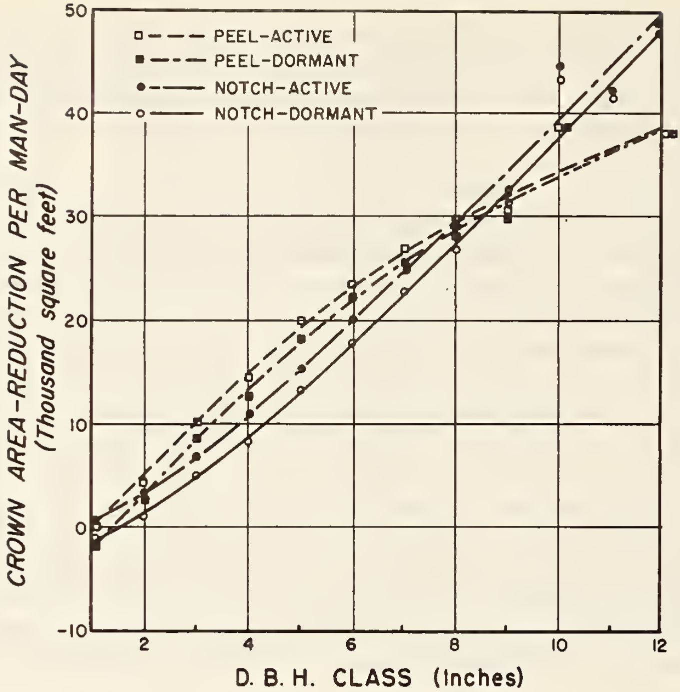


Figure 7.--Crown area reduction (at the end of 6 years) in one man-day by diameter class, type of girdle, and season of treatment.

At the end of six growing seasons the crown-area reduction resulting from eight man-hours of girdling increased greatly with an increase in tree diameter. This increase is due largely to the large increase in tree crown area and the decrease in the number of trees sprouting as tree diameter increases.

Girdling small trees, particularly the 1-inch trees, is of questionable value. By the end of six growing seasons sprouts from these trees had reoccupied most of the space occupied by the original trees and in some cases had occupied more space. As the sprouts become older, the same will be true for successively larger size classes. Girdling these small trees does have a distinct advantage if they are overtopping higher value trees such as shortleaf pine which, if given this temporary release, will usually outgrow the new sprouts.

Time spent in girdling larger trees is obviously more worthwhile than that spent on smaller trees. For example, if one man spends a day notch girdling 10-inch trees in the dormant season, he can bring about as much crown-area reduction as two men girdling 6-inch trees or 24 men girdling 2-inch trees. It follows, then, that if all trees that are overtopping or are interfering with the growth of higher value trees cannot be girdled, the larger trees should be considered first.

SUMMARY AND CONCLUSIONS

The results of studies on factors affecting sprouting are presented in the belief that the information will be valuable to those who want to eliminate undesirable hardwood trees from forest stands as well as to those who are investigating the use of newly developed chemicals for the control of woody plants.

The main study involved 2,400 second-growth blackjack oak trees in low-grade stands in the Missouri Ozarks. The major variables under test were depth and month of girdling; tree diameter, dominance, and crown size; and competition by untreated trees. These variables were evaluated primarily in terms of amount of sprouting and size of sprout clump.

In general those factors that resulted in the least amount of sprouting also resulted in fewer sprouts per sprouting tree, a higher sprout mortality, and a lower growth rate of sprout clumps.

Practically all of the sprouting took place during the first and second growing seasons after treatment and the majority of the sprouts originated at the base of treated trees. The average height growth of sprouts during the first growing season was 4 to 5 times greater than the average annual height growth for the succeeding 5 years.

Trees peel girdled sprouted less, had a higher sprout mortality, fewer sprouts per sprouting tree, and smaller sprout clumps than trees notch girdled. Decreasing the depth below one-fourth inch resulted in definite decreases in the percent of trees sprouting. If a girdle cannot be made less than one-fourth inch into the sapwood it makes little difference how deep the tree is girdled.

For best results, trees should be peel girdled in June. Trees treated in June had fewer trees sprouting, higher mortality of sprout clumps, fewer sprouts per tree, and smaller sprout clumps than trees treated during any other month. Trees treated in the diameter growth period (May, June, and July) sprouted less than trees treated during the dormant season (October to April). If trees cannot be girdled during the diameter growth period, it makes little difference what time of year they are girdled

As tree diameter increased, the percent of girdled trees sprouting decreased and sprout mortality increased. The height of sprouts on peel-girdled trees 6 years after treatment decreased as the diameter of the parent tree increased; whereas, the height of sprouts on trees notch girdled increased as diameter increased. For the same period, trees peel girdled had sprout clumps that increased in crown area as the diameter of the parent tree increased up to 6

inches; over 7 inches the sprout clumps decreased in area. Sprout clumps of trees notch girdled increased in area as tree diameter increased.

All methods of killing the tops of trees larger than 10 inches d.b.h. should be satisfactory and result in a small amount of sprouting; therefore, for these larger trees the choice of method and time of treatment should be made on the basis of convenience and cost.

A girdle made about 36 inches high is preferred to a girdle made about 6 inches high because the high girdle results in approximately 10 percent fewer trees with sprouts and it is easier to make.

Crown class of trees 5 inches d.b.h. and larger had no noticeable effect on the percent of trees sprouting. For trees less than 5 inches, the percent of trees sprouting decreased slightly with a decrease in tree dominance. There was very little difference in sprout mortality among the crown classes of parent trees. The height and width of sprout clumps 6 years after girdling increased as tree dominance increased.

Competition afforded by untreated trees in the stands resulted in no differences in the percent of trees sprouting. However, competition did affect the growth of sprout clumps; the sprout growth decreased as the competition increased.

Time used in girdling trees up to 10 inches d.b.h. is most effectively spent by peel girdling during the diameter growth period. For trees larger than 10 inches d.b.h. there is little difference in the number of trees that can be killed in a given time period by the various types and times of girdling.

Crown-area reduction that can be obtained in a given unit of time increases sharply as tree diameter increases. Time spent in girdling 1-inch trees is of questionable value; time is most effectively spent in girdling the larger trees. One man girdling 10-inch trees can accomplish as much crown reduction as two men girdling 6-inch trees or 24 men girdling 2-inch trees. Therefore, other things being equal, larger trees should be given first priority for girdling.

APPENDIX

Table 1.--Amount of sprouting and size of sprout clumps on blackjack oak trees six growing seasons after girdling by season of girdling

Month of girdling	Trees with living sprouts: Notch girdle	Trees with living sprouts: Peel girdle	Average height of sprout clumps: Notch girdle	Average height of sprout clumps: Peel girdle	Crown area of sprout clumps (per acre)1/: Notch girdle	Crown area of sprout clumps (per acre)1/: Peel girdle
	Percent	Percent	Inches	Inches	Square feet	Square feet
October - April (Dormant season)	69	55	65	59	1497	952
May - September (Growing season)	50	32	54	39	746	305
May - July (Diam. growth period)	42	26	46	35	449	214
June	35	18	42	24	289	78

1/ 180 girdled trees per acre

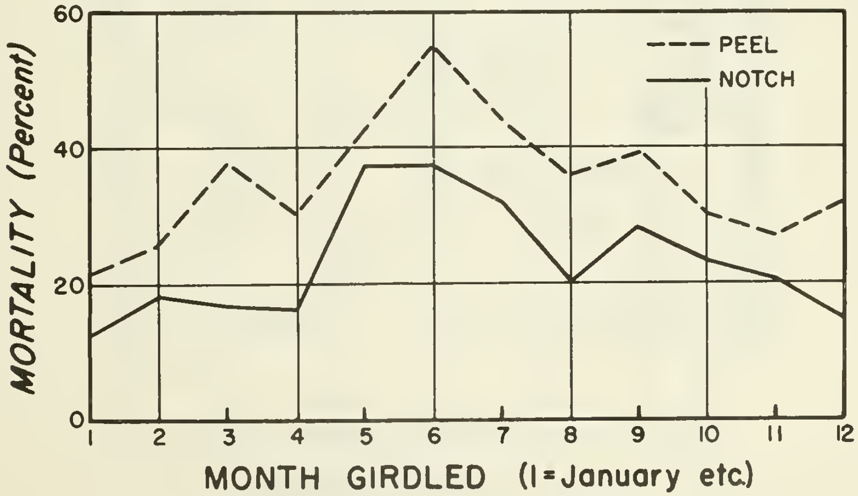


Figure 8.--Mortality of sprout clumps during the first 6 years after girdling by months and type of girdle.

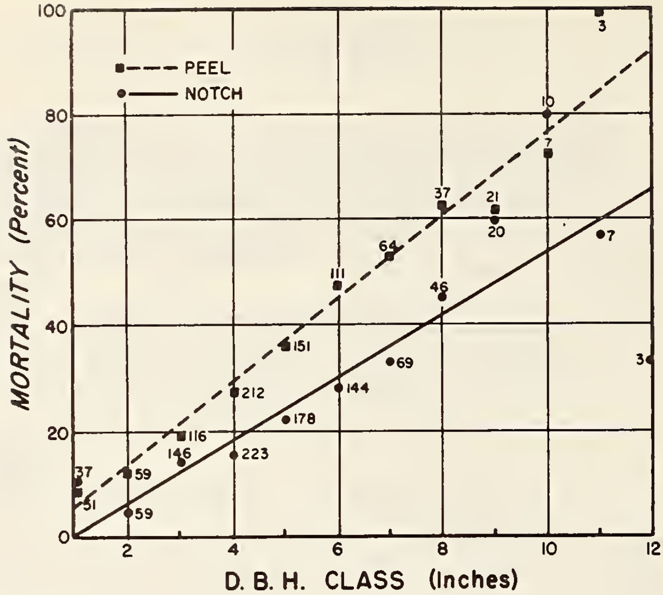


Figure 9.--Mortality of sprout clumps on notch- and peel-girdled trees during 6 growing seasons after treatment by diameter class.

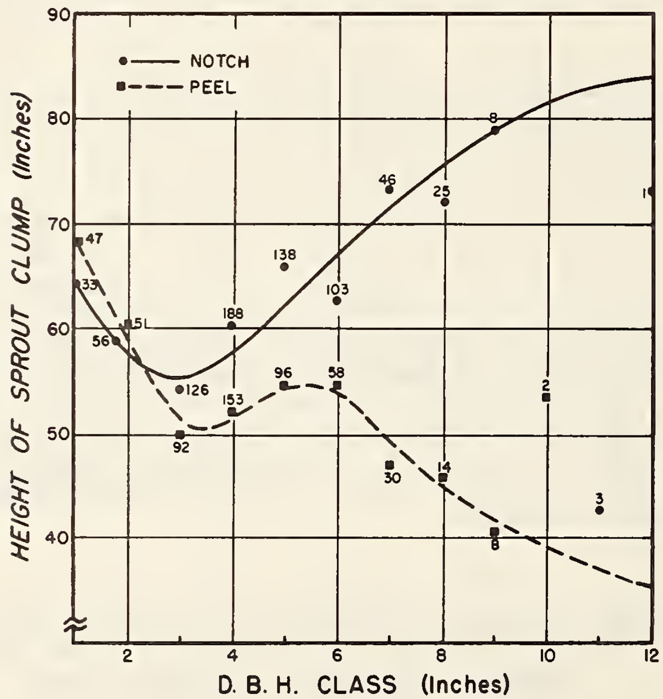


Figure 10.--Height of 6-year-old sprout clumps by diameter class and type of girdle.

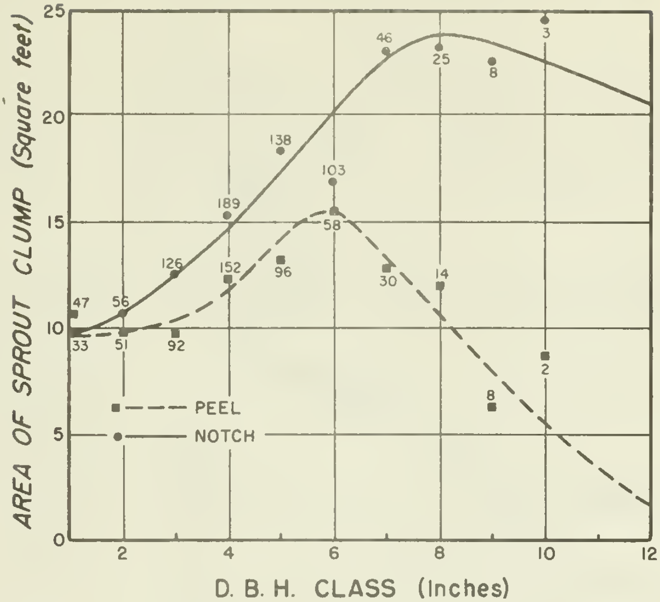


Figure 11.--Area of sprout clumps 6 years after treatment by diameter class and type of girdle

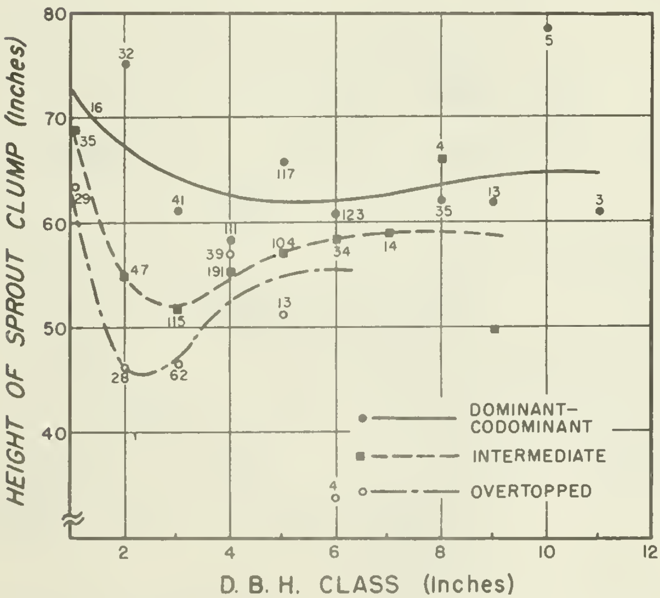


Figure 12.--Height of sprout clumps after 6 growing seasons by crown class and diameter class.

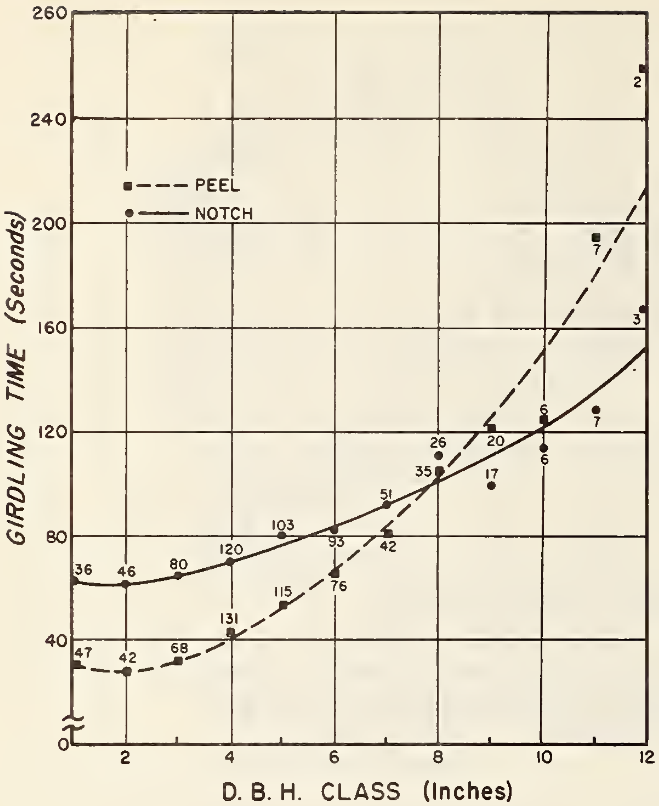


Figure 13.--Time required to girdle one tree by diameter class and type of girdle.

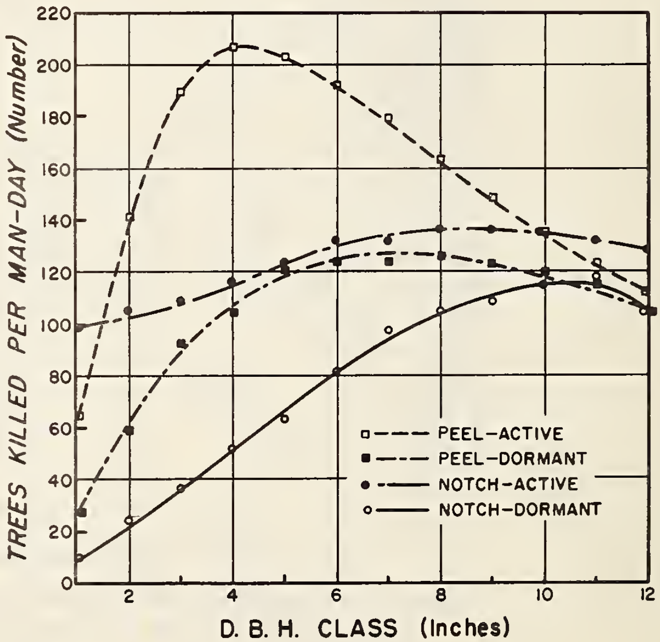


Figure 14.--Number of trees that can be killed in one man-day of girdling by diameter class, type of girdle, and season of treatment.

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